Making sense of shadows: Dr. James Third and the introduction of x-rays, 1896 to 1902

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Abstract • Résumé

The discovery of x-rays was announced by German physicist Wilhelm Conrad Röntgen in December 1895. This review of the introduction of the use of x-rays in Kingston, Ont., shows the rapidity of their adoption in Canadian medicine. By February 1896 "x-ray photographs" were being taken by Captain John Cochrane of the Royal Military College of Canada in Kingston. Initially a scientific and popular curiosity, the new rays were quickly applied to medicine, and by the fall of 1896 the Kingston General Hospital had acquired its own x-ray apparatus. The hospital superintendent, Dr. James Third, became a leading practitioner and promoter of radiographic diagnosis and radiation therapy. He published, in 1902, the first comprehensive review of the diagnostic and therapeutic uses of x-rays by a Canadian physician. Third's writings reveal his technical knowledge, his organized approach to the application of radiography to clinical medicine and his cautious attitude. Like other physicians who have witnessed the introduction of new diagnostic techniques, Third feared that the new technology would usurp the physician's clinical skills.

C'est un physicien allemand, Wilhelm Conrad Röntgen, qui a annoncé la découverte des rayons-X en décembre 1895. Cette revue du lancement de l'utilisation des rayons-X à Kingston (Ont.) démontre avec quelle rapidité elle a été adoptée par la médecine canadienne. En février 1896, le capitaine John Cochrane du Collège militaire royal du Canada à Kingston prenait des «photographies aux rayons-X». Curiosité scientifique et populaire au début, les nouveaux rayons ont été utilisés rapidement en médecine et, à l'automne de 1896, l'Hôpital général de Kingston avait son propre appareil à rayons-X. Le surintendant de l'hôpital, le Dr James Third, est devenu un chef de file de la pratique et de la promotion du radiodiagnostic et de la radiothérapie. Il a publié, en 1902, la première revue détaillée des utilisations diagnostiques et thérapeutiques des rayons-X produite par un médecin canadien. Les écrits de Third révèlent ses connaissances techniques, son approche structurée de l'application de la radiographie à la médecine clinique et sa prudence. Comme d'autres médecins qui ont été témoins du lancement de nouvelles techniques de diagnostic, Third craignait que la nouvelle technologie n'empiète sur les compétences cliniques du médecin.

In the autumn of 1895 German physicist Wilhelm Conrad Röntgen observed the fluorescence of crystals on a screen several metres from a covered cathode-ray tube, and he concluded that this phenomenon must be caused by an invisible ray emanating from the tube. During the next few weeks he established the physical properties of this unknown or "x" ray, most significantly its ability to pass through opaque structures and to blacken photographic plates. Within a year of this discovery, x-rays were being commonly used in medicine as a diagnostic tool, their therapeutic powers were beginning to be appreciated and the modern medical disciplines of diagnostic radiology and radiation therapy had been born.[1-6]

The use of x-rays arrived quickly in Canada, as it did in other parts of the world. Röntgen had submitted his findings to the Würzburg Physical–Medical Society on Dec. 28, 1895, and by early January 1896 news of the discovery had appeared in North American scientific journals and newspapers. In January and February 1896 many scientists throughout North America duplicated and verified Röntgen's experiments. So frantic was the activity during this period that historians Ruth and Ed-

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An abbreviated version of this paper was presented at the Canadian Society for the History of Medicine Annual Meeting, June 10 to 12, 1994, Calgary, Alta.

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ward Brecher[7] have dubbed February 1896 the "x-ray rush." Brecher and Brecher list more than 50 experimenters in North America who studied x-rays before Mar. 1, 1896, among them Dr. John Cox and Hugh L. Callendar of Montreal and J.C. McLennan of Toronto. The most celebrated Canadian event during this period was the use of radiography to locate a bullet in the leg of a patient in Montreal on Feb. 7, 1896.[8]

Previous studies of the early period of the use of x-rays in Canada have described their introduction in specific locations such as Ontario, Nova Scotia and Saskatchewan[9–11] or noted the contributions of pioneers such as Gilbert P. Girdwood and Dr. Alexander Howard Pirie of Montreal and Dr. Maxwell Stevenson Inglis of Winnipeg.[12–14] This article focuses on the work of one physician, Dr. James Third of Kingston, who was involved in the introduction of the new rays. Although he left no personal records such as notebooks or diaries, Third recorded his observations and ideas in three articles published between 1898 and 1902. In 1982 J.K. Lipinski[15,16] searched Canadian and international medical articles published between 1896 and 1920 for original articles on radiology by Canadian physicians. Of the 61 articles cited by Lipinski, Third's article was the first comprehensive review of the diagnostic and therapeutic uses of x-rays by a Canadian physician.

Madame Albani's hand

In 1896 Kingston was a city of approximately 18 000 people. Despite its small size, it was home to two universities — the Royal Military College of Canada (RMC) and Queen's University — as well as a medical school and a teaching hospital.[17] The first documented exposure of a human to x-rays in Kingston was performed as a curiosity by a physics professor at the RMC. On Feb. 17, 1896, the *Daily British Whig* reported that celebrated Victorian singer Madame Emma Albani had had an "x-ray photograph" of her hand taken by Captain John Bray Cochrane of the RMC (Fig. 1).[18] The article noted that "an exposure of forty minutes was necessary, and Albani sat as nearly motionless as possible, during that time." This event was probably a publicity stunt; Canadian-born Albani, one of the leading concert and opera singers of the late 19th century, had complained about the lack of attendance at her concerts. The incident was also reported on page 10 of the *Toronto Globe* of Feb. 21, 1896, but her memoirs make no mention of the x-ray sitting.[19]

On Feb. 20, 1896, a front-page story in the *Daily British Whig* reported that workers at both the RMC and Queen's University had successfully taken "x-ray pictures." In addition to Madame Albani's hand, Cochrane had taken radiographs of the fractured wrist of a veteran of the Crimean War, a man's foot inside a boot and two pairs of stockings, and the hand of a cadet at the college (reproduced in the newspaper). At Queen's University, unnamed workers at the School of Mines had turned the rays on wood, leather and minerals, and they had found that "certain minerals transmit the rays, while others are perfectly opaque."

Cochrane took the lead in publicizing and using the new rays. A member of the first graduating class of the RMC, by 1896 he was an assistant instructor in surveying, military topography, chemistry and physics.[20] None of the surviving records indicates when or how he became interested in x-rays. The subject obviously fascinated him. In March 1896 he gave two public demonstrations, and on Apr. 22 he published an article in the *Jewellers' Circular* of New York entitled "Testing of Precious Stones with the Roentgen Process." This article was based on his observation that x-rays did not penetrate diamonds on Albani's hand.

Soon after, Cochrane was asked to apply x-rays to a medical problem. On May 27, 1896, the *Daily British Whig* published a story concerning Miss Hooper, who had run a sewing needle into the flesh of her palm. Her hand swelled so much that it was impossible to locate the needle; after 2 weeks the pain had become so intense that

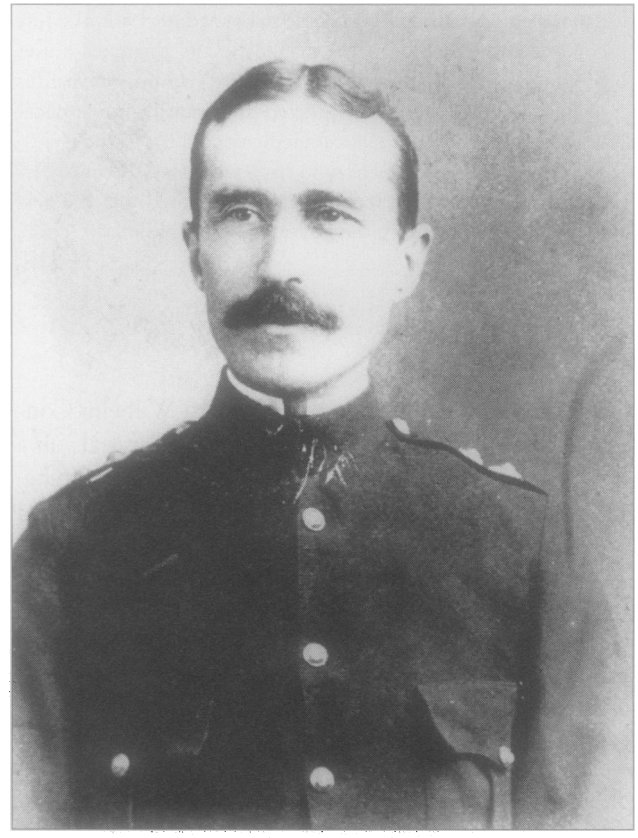

Fig. 1: Captain John Bray Cochrane (1860–1946), professor of physics and chemistry at the Royal Military College of Canada, was the first person in Kingston, Ont., to use x-rays. Photo provided courtesy of Massey Library, the Royal Military College of Canada.

she "decided to utilize the cathode rays, in the hope of getting relief." Cochrane took a radiograph of her hand, which allowed Dr. Ronald Kilborn, a Kingston physician, to locate and remove the needle easily. Localization of foreign objects — such as bullets, shrapnel and swallowed objects — in the body was one of the first medical applications of radiography. The successful radiographic localization and extraction of a bullet from the leg of a patient in Montreal, mentioned earlier, had been reported in the *Daily British Whig* on Feb. 8, 1896, and probably stimulated Miss Hooper to seek Cochrane's help.

During the next few months, Cochrane and his apparatus were much in demand by the physicians of Kingston, and by the fall of 1896 his skills were recognized by an appointment to the position of "cathographer" at Kingston General Hospital. In recording the appointment, the *Kingston Medical Quarterly* stated, "No doubt the Surgeons of this Hospital will by this means be greatly assisted in their diagnosis of obscure cases."[21] Coincident with Cochrane's appointment was the arrival in Kingston of the first x-ray machine specifically for medical use. Until this point, radiographs had probably been taken with Cochrane's own apparatus, fashioned from equipment in the physics laboratory at the RMC. In late September 1896, Kingston General Hospital ordered an x-ray apparatus "of the most improved pattern." It arrived on Oct. 5, and the next day it was tested by Cochrane, who found it "a splendid one, modern and complete in every way." A dark room was set up in the hospital, allowing radiographs to be taken at any time.[22]

Thus, less than a year after Röntgen's initial observations, radiography was established in Kingston. The speed of this development can be attributed to the rapid publication of Röntgen's methods in the scientific literature and to the existence of the equipment needed to produce x-rays (a Crookes' tube and an induction coil) in almost every physics laboratory.[23,24] In addition, the Victorian public was fascinated by the rays, to which were attributed such magical properties as the ability to resuscitate the drowned.[25] The newspaper coverage and public lectures given by Cochrane demonstrate the public interest and excitement that accompanied the arrival of radiography in Kingston; for example, in the newspaper account of the needle localization it was stated that the brave Miss Hooper herself decided to "utilize the cathode rays."

James Third and the first hospital x-ray machine in Canada

It may seem unusual that a physicist, not a physician, introduced the use of the rays in Kingston, but this was in keeping with events elsewhere in Canada. In Toronto and Montreal the early work in x-rays was done in the physics and engineering departments of universities.[26,27] Physicists had both the knowledge and equipment to build and operate the early radiographic machines. However, as the medical applications of radiography grew, physicists withdrew to a technical-advisory role. This transition occurred in Kingston within a year of Cochrane's appointment as "cathographer" at Kingston General Hospital. In February 1897 Cochrane was still busy with radiographic work, but by April a new figure, Dr. James Third (Fig. 2), had come on the scene. The *Kingston Medical Quarterly* of that month reported that, in a case of tuberculosis in a knee, "the question of excision or amputation was readily solved by a skiagraph taken by the Medical Superintendent [of Kingston General Hospital], Dr. Third." ("Skiagraph," from *skia*, the Greek word for shadow, was another term used at the time for a radiograph.) It is unclear why Cochrane withdrew completely from radiography after this date.

Third was born in 1865 in the hamlet of Menie, just outside Campbellford, Ont., and graduated in 1891 from Trinity University, Toronto, with the gold medal in medicine. He practised for 3½ years in Trenton, Ont., and in February 1896 secured the position of medical superin-

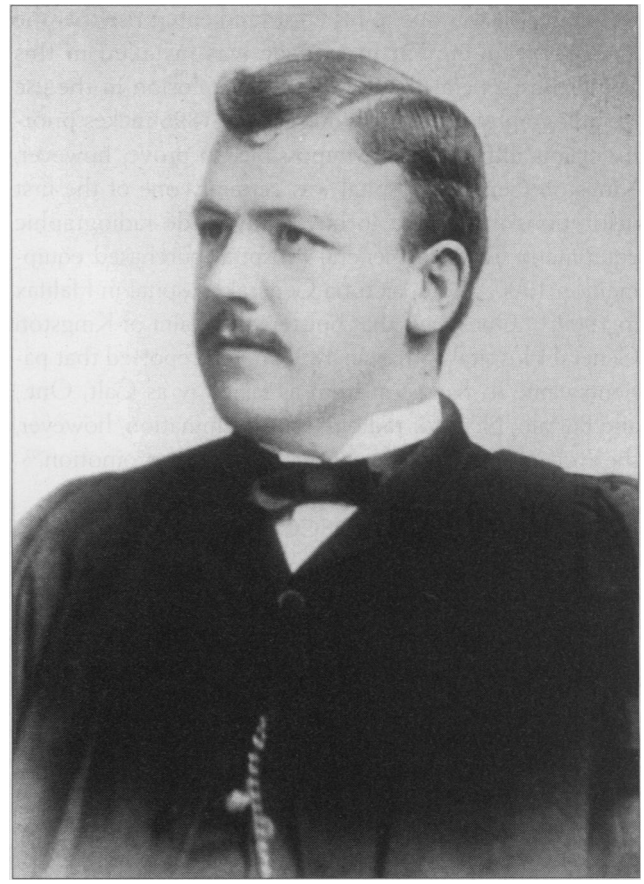

Fig. 2: Dr. James Third (1865–1925), medical superintendent of Kingston General Hospital and later professor and head of medicine at Queen's University, Kingston, Ont., upon his graduation from Trinity University, Toronto, 1891. Photo provided courtesy of Muriel Parker, Emsdale, Ont.

tendent at Kingston General Hospital over 50 candidates. Commenting with regret on his departure from Trenton, the local newspaper stated, "He is enthusiastic, studious, and ambitious to keep abreast with the foremost in his profession: he is cool-headed and of a patient, sympathetic temperament, besides having the indefinable genius of the physician, which like that of the poet, is born, not made. Assuredly Kingston General Hospital will have the right man in the right place."[28] Third did not disappoint his new employers in Kingston. On Nov. 3, 1896, the *Daily British Whig* reported that he had been "most efficient, economical, and attentive, [and] has discovered leaks in our expenses that will result in future savings." But Third was no Scrooge: that Christmas he and his wife served dinner to the patients and staff of the hospital and afterwards entertained the hospital staff in their apartment.

Although there is no mention until 1897 that Third took radiographs, as superintendent of the hospital he must have had a leading hand in the acquisition of x-ray apparatus in early October 1896. It is odd that neither the hospital records nor newspaper reports of hospital meetings make any reference to this purchase.[29] However, when Third died in 1925, his obituary in *CMAJ* stated that "It was due to his effort and enterprise that the first x-ray equipment in Canada was installed in this [Kingston General] hospital."[30] The explosion in the use of radiography in the early months of 1896 makes priority claims difficult, if not impossible, to prove; however, Kingston General Hospital was certainly one of the first institutions in Canada to buy ready-made radiographic equipment. Toronto General Hospital purchased equipment in 1900, as did Victoria General Hospital in Halifax in 1904.[9,10] One point that bolsters the claim of Kingston General Hospital is that, in 1896, it was reported that patients came to Kingston from as far away as Galt, Ont., and Buffalo, N.Y., for radiographic examination; however, these claims may have been small-town self-promotion.[22]

Dr. Third's fluoroscope

After helping to acquire the hospital equipment, Third introduced a new way of using x-rays to visualize the body. Images could be obtained not only by exposure of photographic plates but also by interposing the patient between the x-ray tube and a fluorescent screen. The image of the body could be seen on the screen, thus allowing real-time observation of heart contraction or of respiration. Early fluoroscopes were simple devices that the observer held up to his or her eyes. The minutes of the Kingston Medical and Surgical Society of Oct. 4, 1897, reported that "Dr. James Third gave an interesting demonstration with his recently devised and perfected fluoroscope." The exact design of Third's fluoroscope is unknown, but a medical student on whom it was tested (students and cadets having been favourite subjects for experimentation) later recalled that it involved a piece of cardboard coated with a fluorescent medium. The student remembered his wonder at seeing the movement of the bones of his own hand.[31] Ironically, Third's new piece of apparatus was first used to examine the fractured hand of the commandant of the RMC.

Armed with the hospital's x-ray machine (Fig. 3) and his fluoroscope, Third began to accumulate a great deal of experience in radiography. In 1900, when he stepped down as hospital superintendent, he was appointed hospital radiographer. Third recorded his experience in three articles published in the *Kingston Medical Quarterly* in 1898, 1899 and 1902 (the final article was reprinted in the *Canada Lancet*).[32–35] These articles are the most comprehensive early discussion of radiography by a Canadian physician and reveal the reaction of a turn-of-the-century physician to the discovery of x-rays.

Excitement tempered by caution

The introduction of x-rays engendered great excitement among physicians. Until this discovery, medical diagnostic equipment consisted mainly of the stethoscope, the ophthalmoscope, the microscope and a few blood and urine tests. X-rays added the ability to see directly inside the body. As Reiser[36,4] points out, radiography was the culmination of the 19th-century search for ways of visualizing the inside of the body, a search that had already led to the invention of the ophthalmoscope in

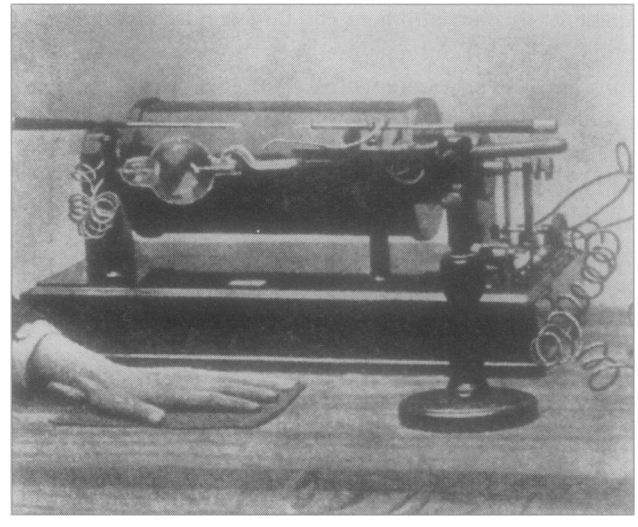

Fig. 3: X-ray apparatus acquired by Kingston General Hospital in October 1896 and used by Dr. Third for diagnosis and therapy from 1896 to 1902. The large cylindrical object in the background is the induction coil for generating a high voltage; in the foreground are the x-ray tube and a hand placed over a photographic plate. This photo was first printed in the *Kingston Medical Quarterly* (1898; 2: 65) and is reproduced courtesy of the Queen's University Archives.

1850 and the laryngoscope in 1857. The *Canada Lancet* stated, "we are still glowing with the enthusiasm awakened by the discoveries of Roentgen and his co-workers, who have taught the eye to penetrate living tissues, and to see, as by the light of day, conditions heretofore concealed from us."[37]

This enthusiasm is registered in Third's descriptions of the fluoroscopic appearance of such structures as the spleen: "with each respiration it has the appearance of turning a somersault owing to the greater degree of movement of its anterior border."[34] As a clinician, he seemed delighted that radiography might challenge the conventions of basic science. Commenting on the fluoroscopic appearance of the diaphragm, he said: "Physiologists tell us that this muscle becomes flatter with each inspiration. This is a mistake. It plunges up and down piston-like, the curve remaining practically unaltered."[34]

Although he was obviously fascinated by the revelatory powers of the rays, Third was reluctant to accept their usefulness in medicine immediately. His approach to the medical application of x-rays was summed up in the heading of the last paragraph of his 1902 article: "CAUTION!" The first sentence of the same article shows his balance of enthusiasm and caution:

> The Roentgen ray, as a diagnostic agent, is no longer an experiment. Its growth has been phenomenal. It came up through the stage of criticism with unprecedented rapidity, receiving few scars and for these it is therapeutically the richer. That too much has been claimed for the rays in certain quarters, seems tolerably certain, but it is equally true, that inexperience and inferior apparatus have not infrequently discounted its true value. Its real enemies at the present moment are its rash inexperienced and selfseeking advocates.[35]

One might expect that Third's caution was based on fear about harmful effects of x-rays. Two pieces of evidence suggest that Third knew about their potential for inflicting damage. Members of his family recall that "his hands were raw with burns and sores from using radiation" (Marlene Dooher, Campbellford, Ont.: personal communication, 1993). In addition, when Third used x-rays for therapy, he protected patients with sheet lead.

However, none of Third's articles mentions any ill effects of radiation. Rather, his cautious attitude resulted from concern that the rays would be introduced into medical practice without proper study of radiographic technique and understanding of how normal anatomy appears in radiography.

Understanding radiography and expanding its use

Implicit in all of Third's writing was the awareness that several preparatory steps were needed before radiography could be useful in medicine. First, the clinician needed to have a firm grasp of the technical requirements for the production of x-rays. Third demonstrated his own knowledge through his recommendations about sources of electricity and ways to avoid overheating the tube. Next, the best way of obtaining images of different parts of the body needed to be established. This often boiled down to a choice between exposure of a photographic plate or fluoroscopy. Third thought that the former offered the advantage of producing a permanent image that could be studied in detail and was thus the best way of diagnosing calculi and bone disorders. Third's radiographic technique included the use of contrast media in examination of the stomach as well as "stereoscopic" radiography, in which radiographs of the part of the body of interest were taken from two separate points and the two images mounted in a viewer to provide a three-dimensional image.

The final step was to understand the changes in the radiographic images of anatomy caused by pathologic processes. Third soon recognized that diseases could alter the radiographic appearance of an organ in one of two ways: by making the organ more or less radiopaque. Disease in bone caused lucent areas (Fig. 4); lung disease produced dark shadows. In addition, pathologic conditions such as an aneurysm could change the shape of normal anatomic structures such as the thoracic aorta.

Third's thoughtful study of radiographic technique and anatomy allowed him to develop the expertise to use x-rays in a remarkably wide range of clinical applications (Table 1). Cochrane's use of radiography had been limited essentially to finding foreign bodies and delineating fractures; Third expanded the repertoire to include the diagnosis of medical conditions such as pneu-

Fig. 4: Radiograph of tuberculosis of the elbow, taken by Dr. Third. Despite the poor quality of the image, rarefaction of the bones and soft-tissue swelling can be seen. This photo was first printed in the *Kingston Medical Quarterly* (1900; 2: 104) and is reproduced courtesy of Queen's University Archives.

monia and tuberculosis. He noted that "the Roentgen process . . . will pick out a tuberculous focus, in many cases, before either the stethoscope or microscope." In his 1899 article, he reported on 52 cases of suspected pulmonary disease examined by radiography; of these, 13 were diagnosed as tuberculosis. In only about half of the cases was there a positive result of a test for bacilli from sputum specimens. Third's achievements are all the more remarkable when one considers the poor, shadow-like quality of the images produced by his apparatus (Fig. 4).

Table 1: Uses of x-rays described by Dr. James Third

Localization of foreign bodies
• Bullets
• Shot
• Needles
• Coins
• Slate pencils
• Pieces of glass
• Pieces of iron
• Pieces of copper
Diagnosis
Fractures
Dislocations
Diseases of bone
• Tuberculosis
• Subperiosteal abscess
• Rickets
• Bony ankylosis
• Exostosis
• Loose cartilages
• Syphilitic dactylitis
• Osteosarcoma
• Chondrosarcoma
Calculi
• Kidney, ureter or bladder stones
• Gallstones
Diseases and conditions of the heart
• Cardiomegaly
• Pericardial effusion
• Displacements of the heart
• Chronic endocarditis
Conditions of the mediastinum
• Thoracic aneurysm
Diseases and conditions of the lungs and pleurae
• Pleural effusions
• Pneumonia
• Tuberculosis
Diseases of the stomach
Diseases of the liver
Diseases of the spleen
Diseases of the kidneys
Therapy
• Skin cancer
• Lip cancer
• Breast cancer
• Psoriasis
• Lupus vulgaris

Third also pointed out radiography's potential for resolution of the diagnosis in cases in which the patient's symptoms and signs suggested more than one disease. This application must have delighted one of Third's acquaintances, the great bedside teacher Dr. William Osler.[31] Third noted the value of radiography in distinguishing cardiomegaly from a pericardial effusion.

> A diagnosis without the ray is notoriously uncertain, with it the task is comparatively easy. In pericardial effusion the regular wavy outline of the left ventricle, with each systole, is no longer evident, its place having been usurped by a bulging mass, the appearance of which is at once diagnostic.

Even in differential diagnosis, Third sounded a note of caution. He was aware that occasionally his own senses were more acute than x-rays: "That the x-ray can detect a cavity in the lung is a fact beyond question; that auscultation frequently diagnoses a cavity, which the rays show has no existence, is also a fact. This I have verified in the post mortem room." Like other physicians who have witnessed the introduction of new diagnostic techniques, he was concerned that the new technology could replace careful bedside analysis of the patient's symptoms and signs.

> For the present, at least, let us consider it a valuable adjunct to other means of diagnosis rather than a keen competitor for supremacy. We must not abandon the old method of drawing conclusions by a process of inductive reasoning after a thorough and searching examination. To do so would make us mere automatons.

Third's scepticism was also revealed in his attitude toward radiation therapy. Although he had initially dismissed x-rays' healing powers, by 1902 he reported personal experience in the treatment of benign and malignant skin conditions. He was particularly impressed by the rays' palliative effect on a chest-wall recurrence of breast cancer.

Third was by no means the first North American physician to take a cautious and careful approach to radiography. In 1897 Dr. Francis Henry Williams[38] of Boston published his radiographic experience in a 57-page essay in the *Medical and Surgical Reports of the Boston City Hospital*. Like Third, Williams emphasized the importance of a thorough understanding of radiographic technique.

Third's conclusions may not have been original, but they were always based on his own experience and observations rather than the ideas of Williams and others. When Third's views were published in the *Canada Lancet* in 1902, they surely had a positive influence on physicians across Canada and helped to earn radiography a respected place in Canadian medicine. In addition to reinforcing the subservience of radiography to clinical reasoning and demonstrating the importance of radio-

graphic technique, his writings helped to resolve the debate over whether the control of radiography should be in the hands of physicians or lay people. He stated emphatically, "There are three things that should never be placed in the hands of the patient: the hypodermic syringe, the thermometer and the x-ray photograph."[35]

He felt that only physicians had the knowledge and skill to interpret radiographs accurately, but this power brought with it the responsibility of proper training. Physicians must "learn to interpret their results just as they have learned auscultation and percussion; . . . it is only from those whose experience and careful study of the subject warrant their speaking with authority that an x-ray diagnosis should be accepted."[35]

Teaching radiology

These attitudes certainly influenced one group of physicians: the medical students he taught at Queen's University. Early in 1899 Third offered "an evening with the fluoroscope" for students in their final year. The event was recorded in the *Queen's University Journal* on Feb. 4, 1899.

> The class gladly accepted the offer and spent last Monday evening at the hospital where the ghosts of their physics days were called up with all necessary accompaniments, dim lights, blue blazes and ominous cracklings. Many valuable hints were given, the result of the original research of our excellent Hospital Superintendent.[39]

Third probably set the following question that appeared in the examination papers of the Faculty of Medicine in 1901–02: "Describe briefly the apparatus used in producing the X-Rays and explain the use of these rays."

Later in his career, Third served as head of the Department of Medicine at Queen's University and, although he withdrew from active work in radiography, he was instrumental in setting up the university's first course in medical radiology. On Oct. 5, 1917, he presented a report on instruction in radiography and electrotherapy to the medical faculty. The report included a proposal for a course for fifth-year medical students.

> The general aim of this course is to give the fifth year medical students such an acquaintance with modern X-ray outfits, with radio-activity and with radiations of all kinds of which any clinical use is made, that he will be an intelligent operator of the apparatus necessary for such work, that he will not be imposed on by fads and, in buying equipment for himself, will not be at the mercy of the dealers.[40]

Third hoped that "an occasional enthusiastic student may desire to pursue this field of work further and be given access to the hospital equipment under the combined direction of the Professor of Medicine and the Physics Department."[40] The course outline was remarkably comprehensive and included such topics as the nature of x-rays, radiation protection, apparatus and technique and radioactivity. The report was received and adopted, and plans to introduce the course were made almost immediately. Recognition by the leaders of academic medicine at Queen's University that radiology should have a permanent place in the medical curriculum was a fitting tribute to Third's career and accomplishments.

I thank Joanne Breadner for research assistance; Stuart Renfrew, Shirley Spragge and Paul Banfield (Queen's Archives); Benoit Cameron (Massey Library, Royal Military College of Canada); Dr. Anthony Travill; Muriel Peppler, Muriel Parker and Marlene Dooher (members of Dr. Third's family); Dr. Jacalyn Duffin for her comments on the manuscript; and Sherry Mott for manuscript preparation.

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